Coupling ground motion simulation with regional modelling for rapid impact assessment

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1. Introduction

QuakeCoRE undertakes ground motion simulations as part of its computational workflow. Impact assessment is one of the subsequent downstream outcomes, and allows QuakeCoRE to assess estimated impacts for earthquakes – both recent ruptures and potential future earthquake scenarios. When coupled with near-real-time (NRT) ground motion modelling, these tools also provide NRT assessment. Following this, the susceptibility of a location or region to the earthquake-induced geotechnical and geologic hazards can be assessed.

The three impact assessment types are currently considered: macro impact (via PAGER), liquefaction and landside. In this poster attention is given to the first two of these models which have been operationalised, while landslide model implementation is currently on going

2. Macro socio-economic impacts via USGS's PAGER application

Prompt assessment of global earthquakes for response (PAGER) is a system that provides fatality and economic loss impact estimates from the USGS.

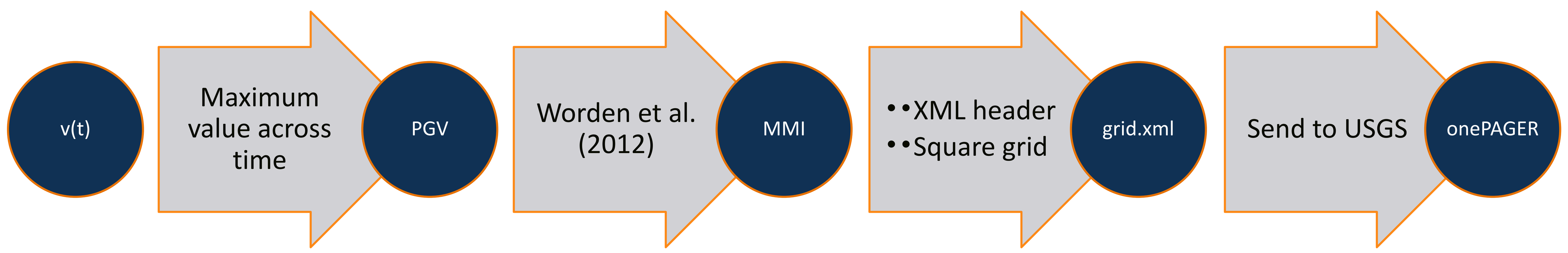
QuakeCore runs PAGER on the outputs of phyiscs-based simulations to obtain onePAGER (summarized) outputs. The simulation stores ground motion every few increments in time producing ground velocity v(t) maps.

Sample onePAGER outputs can be seen in Figure 1.

The left example contains a scenario where empirical ground motion modelling (which uses distance from rupture) are used to calculate ground motion. The example on the right side is produced from physics-based simulation results.

The predicted impacts from the physics-based results are seen to give greater estimated fatalities and economic losses than the empirical data.

Whereas the empirical data has greater shaking over a smaller area, larger population centres are reached with greater ground motion in the physics-based simulation.



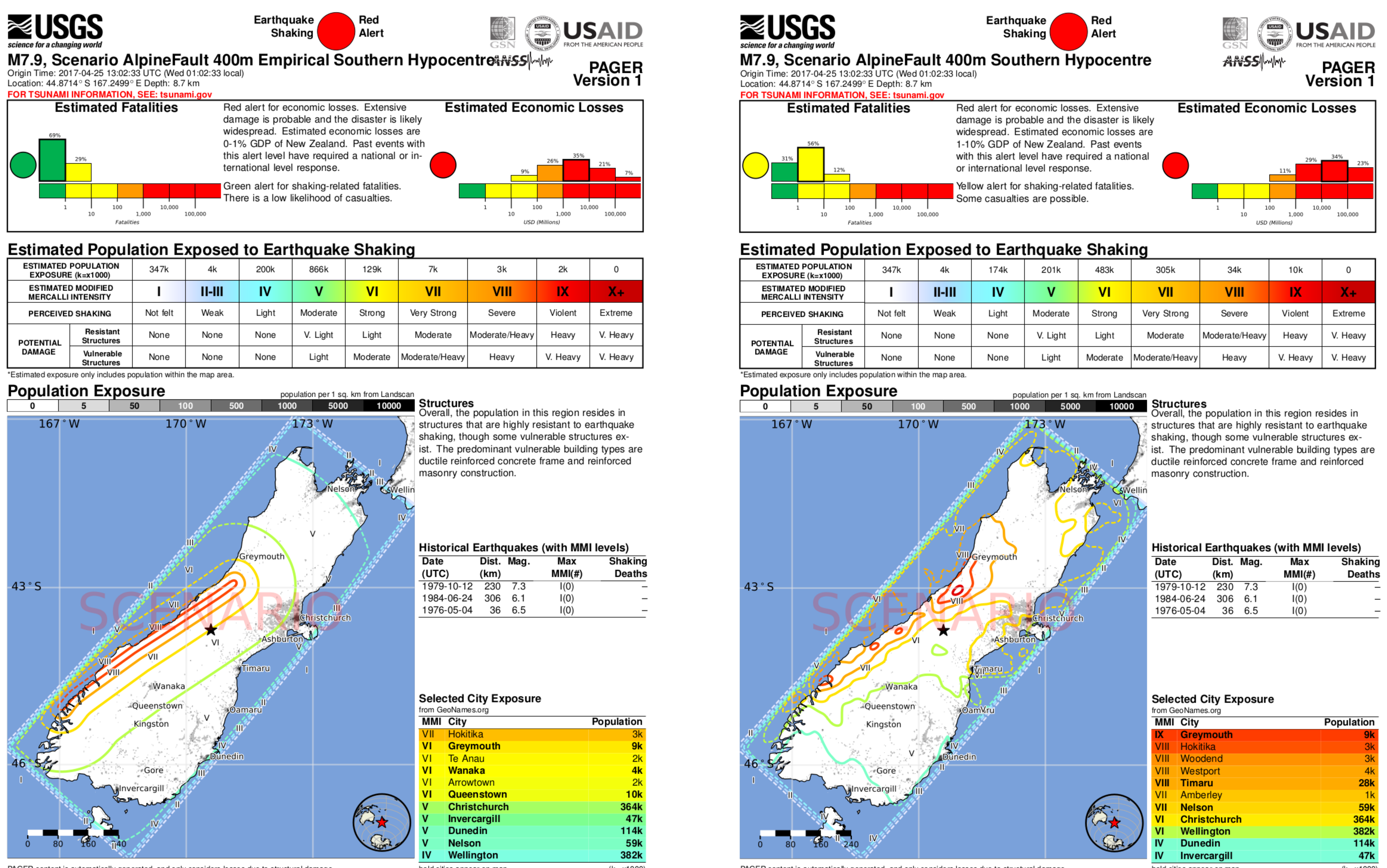


Figure 1: onePAGER summary of an Alpine fault scenario produced by USGS. Left – empirical based, right – physics based simulation.

3. Regional liquefaction impacts via geospatial modelling

Liquefaction probabilities for a given rupture are generated as part of the computational workflow. The PGV maps are generated from the ground motion simulation and these values are fed into the model to determine the probability of liquefaction for that location.

The liquefaction model was developed by Zhu et al. (2017). There are two primary models that are used for these calculations: a coastal model (model 1) and a general model (model 2). The coastal model has the best fit for events that have liquefaction occurring, on average, 20 km from the coast. Future research into this area will compare known liquefaction in NZ to these probability values; hence undertaking further validation for NZ conditions.

By using a constant PGV map, the susceptibility to liquefaction can be determined across New Zealand. Figure 2 illustrates the general model.

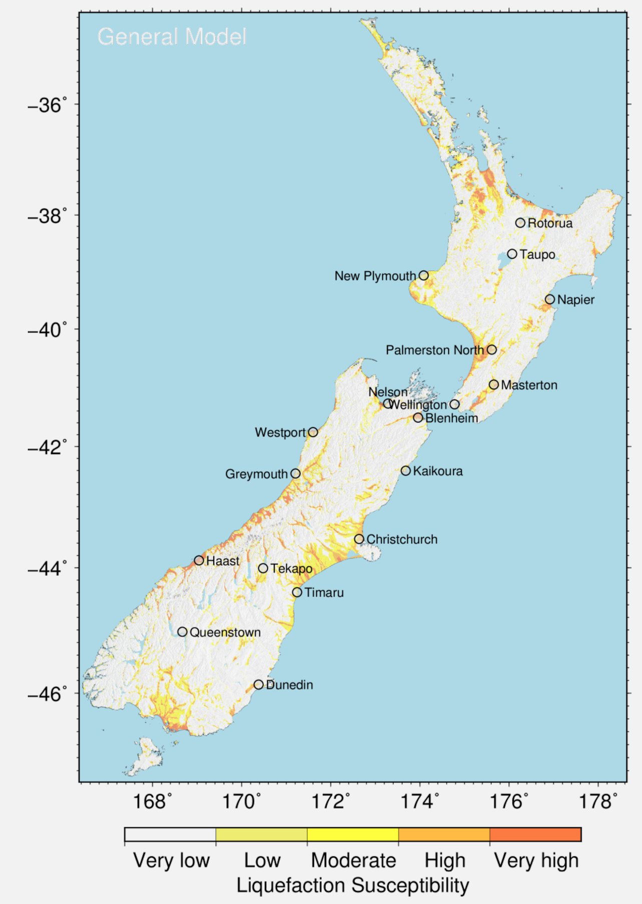


Figure 2: NZ Liquefaction Susceptibility for the General model

The probability of liquefaction for a possible future Alpine Fault scenario is shown in Figure 3. This was generated using a NZ-specific Vs30 and general liquefaction models.

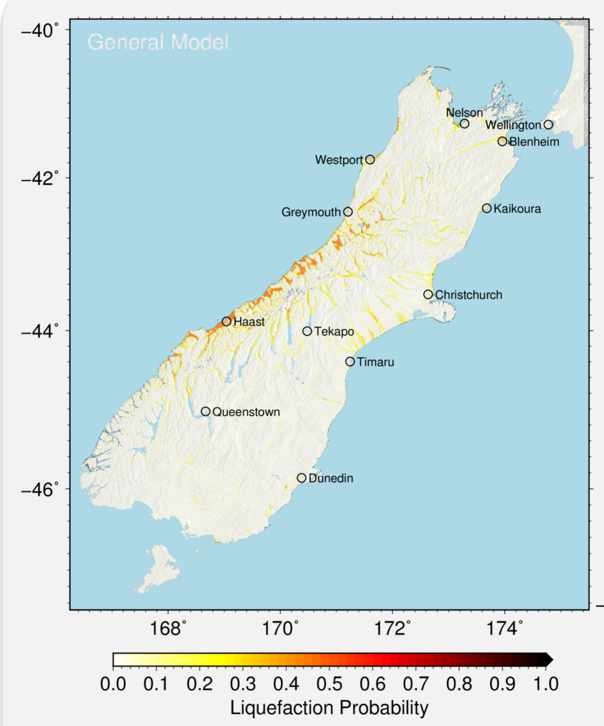


Figure 3: Liquefaction probabilities for potential Alpine Fault scenario

Liquefaction probability plots were also generated for the Christchurch (2011) simulations (Figure 4).

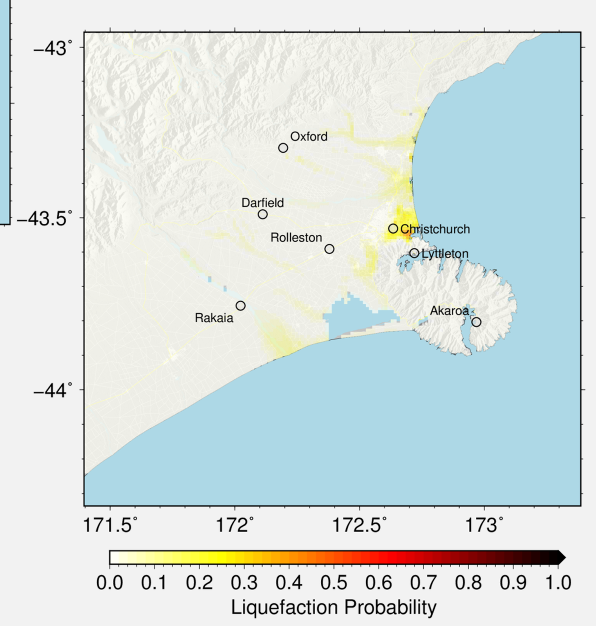
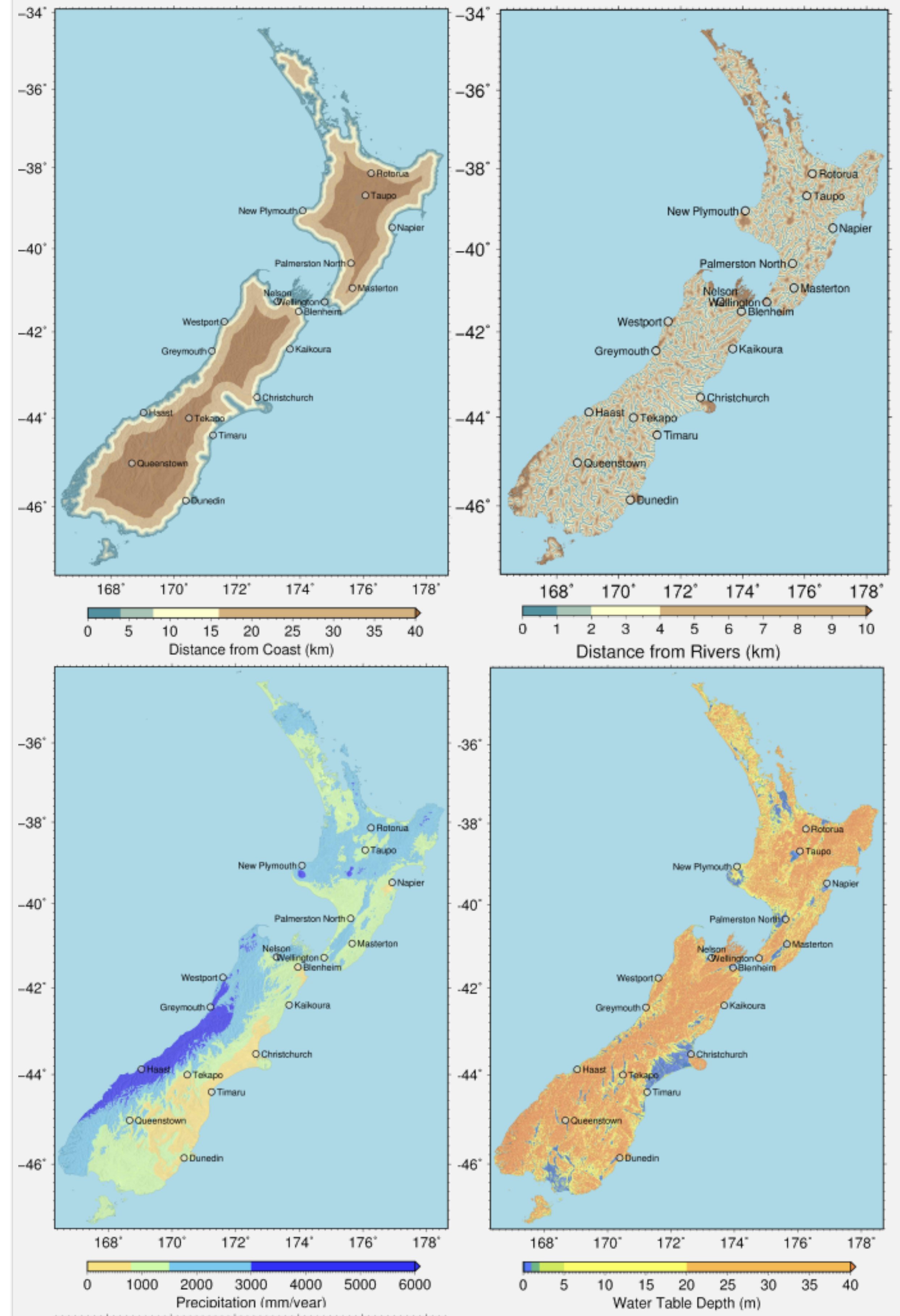
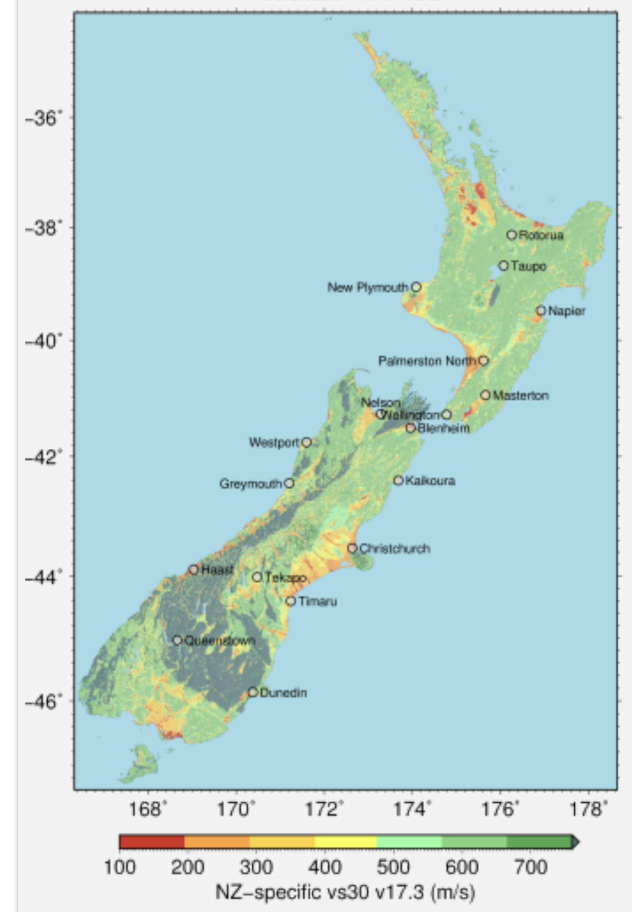


Figure 4: Liquefaction probabilities for Christchurch Mw 6.2 2011

Liquefaction model inputs the PGVvalues from ground motion simulations combined with the static models of: distance from rivers / coast, annual rainfall, Vs30 and water table depth. The plots of these inputs are shown in Figure 5.





QuakeCoRE has developed a Vs30 model specific for NZ (Foster et al, 2017). It is used as part of the liquefaction model inputs. The Zhu et al (2017) liquefaction model was originally developed with topo-based Vs30 estimates. The liquefaction susceptibility and probability plots have used the NZ-specific Vs30 model.

Figure 5: Geospatial inputs